

**MECHANICAL ENGINEERING DEPARTMENT
UNITED STATES NAVAL ACADEMY**

EM423 - INTRODUCTION TO MECHANICAL VIBRATIONS

COURSE OBJECTIVES AND POLICY

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1. **Introduction.** *EM423 Introduction to Mechanical Vibrations* covers the dynamic behavior of engineering structures. The course is a combination of classroom theory, laboratory course work, and a major project. The course is an elective, and includes a combination of traditional vibration theory and some state-of-the-art work. We do not have time to go into the new work in detail, but it is an important aspect. Grades are assessed by a combination of tests and reports. The presentation at the end of the project also forms part of the final grade.

2. **Background.** Most engineering structures are capable of vibration, and will vibrate at certain frequencies. Often these vibrations have little effect on the functionality of the structure, and can be ignored. With the increasing trend toward slender and lighter structures, the vibrational behavior of structures is of increasing significance. Examples of catastrophic failure are flutter in aircraft wings, and fatigue. Non-catastrophic problems include topics such as radiated noise (causing both nuisance and increased likelihood of the military being detected), motion sickness, "white finger," and so on.

3. All real structures possess an infinite number of degrees of freedom, which means they need an infinite number of independent coordinates to fully define their motion. This can only be achieved using continuous equations. Unfortunately, for other than very rudimentary structures, the equations become very complex, and simplifications have to be made. The most common approach is to discretize the problem, and treat even the most complicated structure as a much simpler one. The equations and analysis are proportionately simpler. This method is a standard one in most vibration engineering, and usually defines a structure with sufficient accuracy.

4. **Course details.** The course covers the following main topics:
- a. Vibration of “simple” continuous systems; strings, rods, shafts and beams.
 - b. Single Degree of Freedom (SDOF) vibration of a mass-spring-damper.
 - (i) Free response
 - (ii) Response to harmonic excitation
 - c. Multi Degree of Freedom (MDOF) systems
 - (i) Vibration absorber
 - (ii) Decoupling the equations to several SDOFs.
 - (iii) An introduction to experimental modal analysis - a method of finding a mathematical model of an existing structure.
5. **Requirements.** The course is primarily taught from handouts, but there is also some use of the text: “Engineering Vibration,” by D. Inman..

Any form of calculator may be used for all assignments, including tests. Computers may be used for homework assignments and project work, but may not be used in tests.

6. **Homework.** Homework is assigned for each topic. You should endeavor to complete the problems on your own, but if you cannot make reasonable progress you may seek help. This does not mean you may copy or submit someone else's work as your own. Extra credit problems have to be submitted with the relevant examination (6-weeks or 12-weeks) in order for them to be included in the grade.

7. **Extra Instruction** I consider extra instruction a necessary and important part of the course. I will be very surprised if you understand everything I give in class, and EI is the place and time to sort it out. When you are solving problems, if you have not made significant headway in about 20 minutes, don't waste your time. Bring your attempt to me, and we'll discuss it in EI.

EI sessions can be a few minutes to a few hours - what you want, and mostly when you want it. You may drop in for EI any time I am in my office or laboratory. If I am not available, you may either email or phone. If you can't find me, don't just complain about it. Leave a message and I will get back to you ASAP.

8. **Project.** The project is a major part of this course, and accounts for a significant part of your final grade. Projects may be theoretical, experimental or case studies, and are completed in groups of 2, 3 or 4 midshipmen. If you have a subject you think is suitable, contact your instructor for advice. The project is written up as a formal report. The project is also presented to the rest of the section during the time allocated for the final examination. Both the report and presentation are graded. A separate handout, giving the project policy and details, will be issued later in the course.

9. **World Wide Web.** I maintain a WWW page for EM423. This page has copies of the handouts. Access to the page is from my home page at:

<http://web.usna.navy.mil/~ratcliff/>

or from the Mechanical Engineering home page, under the COURSES button. You are expected to check this page from time to time.

10. **Grading and examinations.**

6-week test (1 hour)	25%	
12-week test (1 hour)	25%	
Project	40%	(a breakdown of this grade is in the separate Project Policy Statement)
Instructor input	10%	

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